

A REVISION OF THE FLOWER BUGS (HETEROPTERA ANTHOCORIDAE) OF THE AUSTRALIAN AND ADJACENT PACIFIC REGIONS — PART II

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Fig. 1

GENUS *CARDIASTETHUS* Fieber

Cardiastethus Fieber, 1860, Wien. Ent. Monat., 4, 266.

In addition to the reference in Van Duzee, 1917, Cat. Hem. Nth. Mexico, 295, there is Zimmerman, 1948, Insects of Hawaii, 178.

Body oblong or ovate pubescent. Rostrum surpassing anterior coxae. Posterior margin of pronotum deeply excavate, lateral margins straight or sinuate. The channel of the scent gland surpassing the middle of the pleurae and directed anteriorly at the apex. Anterior tibiae usually armed with a row of short denticles on their inner side.

This genus is very well represented in the fauna of the regions dealt with here.

The species can be separated by the following key:

KEY TO AUSTRALIAN AND ADJACENT REGIONS SPECIES OF *CARDIASTETHUS*

- | | | | |
|----|---|--------------------------------------|---|
| 1. | Head much wider than long | <i>C. inquilinus</i> China and Myers | |
| | Head not, or little, wider than long | | 2 |
| 2. | Small species, less than 2 mm. in length | <i>C. poweri</i> White. | |
| | Larger species more than 2 mm. in length | | 3 |
| 3. | Second segment of antennae not longer than width of head across eyes | <i>C. minutus</i> Popp. | |
| | Second segment of antennae longer than width of head across eyes | | 4 |
| 4. | Pronotum almost rectangular, anterior angles produced in front of the anterior margin (fig. 1C) | <i>C. aridimpressus</i> sp. nov. | |
| | Pronotum considerably broader posteriorly than anteriorly, anterior angles not produced | | 5 |
| 5. | Cuneus in part rosaceous, male genitalia in the form of a large plate over 500 μ long, female genitalia also very long (ca. 350 μ) | <i>C. consors</i> White | |
| | Cuneus not rosaceous, male genitalia do not exceed 350 μ nor the female genitalia 250 μ | | 6 |
| 6. | Brown species | <i>C. lincolniensis</i> sp. nov. | |
| | Light species, mainly yellow | | 7 |

7. Lateral margins of pronotum rounded with four long hairs on each side as well as the usual short pilosity. Hind margin of pronotum virtually straight. Terminal pair of antennal segments fairly short (172-210 : 220-240) *C. noumeensis* sp. nov.
Lateral margins of pronotum sinuate without four long hairs. Hind margin of pronotum excavate. Terminal pair of antennal segments longer (both 280-290) *C. fulvescens* (Walk.)

CARDIASTETHUS INQUILINUS China and Myers

Cardiastethus inquilinus China and Myers, 1929, A.M.N.H., (10) 3, 119.

Oval, dark brown shading to yellow brown towards apex of head and anterior lateral margins of pronotum. First and second antennal segments, rostrum, and legs yellowish.

Head short and broad, slightly longer than interocular width (17: 13), rostrum reaching apex of anterior coxae. Ratios of length of antennal segments 7:17:12:14 (same scale as above). Pronotum flattened with calli feebly elevated, distinctly but broadly impressed in the middle behind anterior lobe. Anterior margin straight, not emarginate.

Left genital style of the male conspicuously large and spatulate, strongly widened and truncate at apex. Length 2.1 mm.

Loc. South Australia. The original specimens were taken in the nest of an Oxyopid spider near Renmark, S.A.

CARDIASTETHUS CONSORS White

Fig. 1, A-B

Cardiastethus consors White, 1879, Ent. Mo. Mag. 16, 143.

'Yellowish, clothed with long pale hairs; head, pronotum anteriorly and posteriorly, and the abdomen dilutely reddish or yellowish fuscous; scutellum darker, cuneus exterolaterally rosaceous; hemi-elytra more or less fusconebulous; first segment of the antennae apically infuscated, second with the apical third fuscous black, third fuscous brown; membrane dilutely brownish fuscous with indistinct concolorous veins, near the base of the exterior vein a small triangular luteous spot. Vertex and the posterior part of the disc of the pronotum transversely rugulose, the latter with the lateral margins and the hind margin transversely punctate; scutellum subrugulose, the posterior lobe of the disc of the pronotum transversely impressed.

Length, 3 mm.' (translated from White's Latin description).

There are several specimens in the Woodward Collection available to the author for study which fit this description. From them the following standard measurements (in microns) have been obtained.

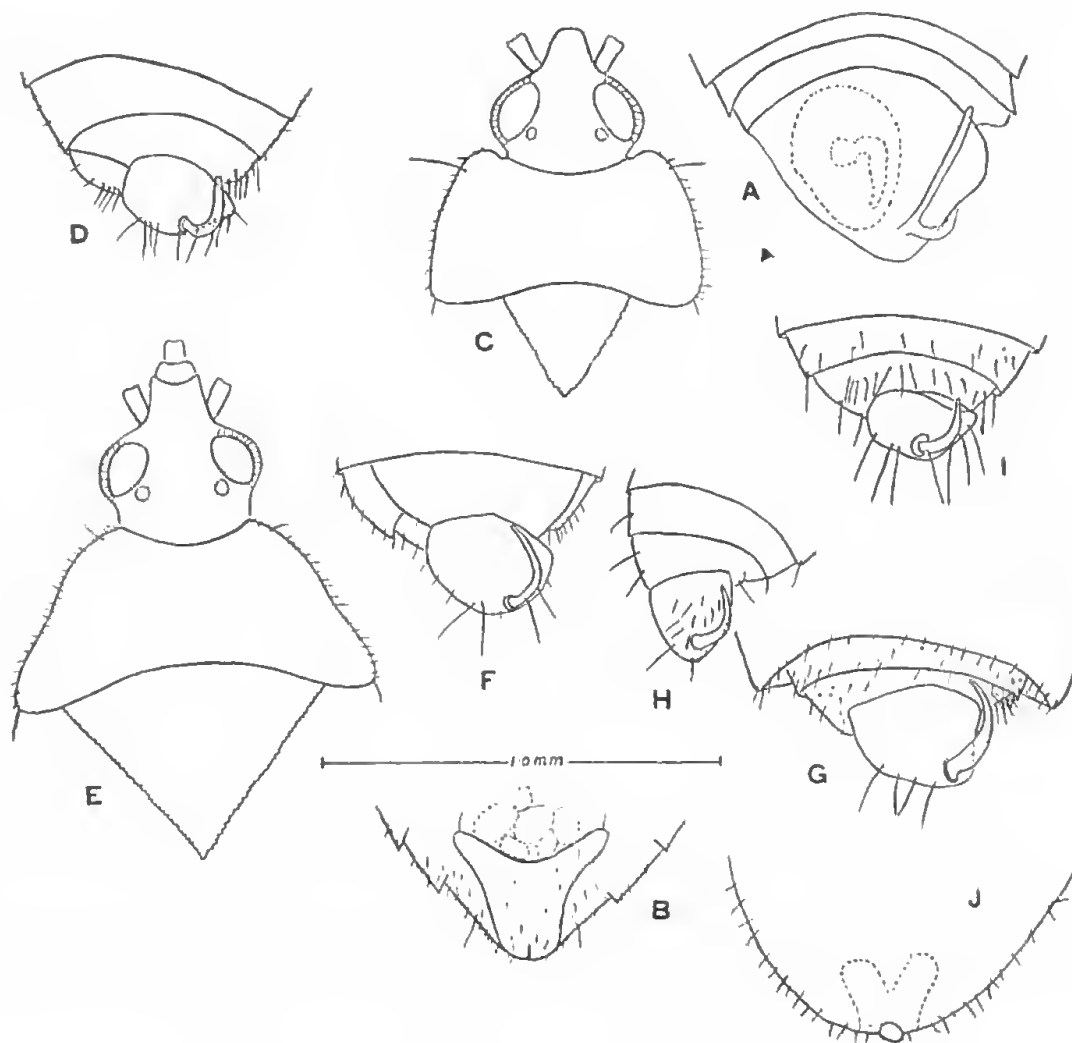


Fig. 1. A-B, *Cardiaestethus consors* White. Male, A, apex of abdomen from below. Female, B, apex of abdomen from below. C-D, *Cardiaestethus aridimpressus* sp. nov. Male, C, head and pronotum; D, apex of abdomen from below. E-F, *Cardiaestethus lincolnensis* sp. nov. Male, E, head and pronotum; F, apex of abdomen from below. G, *Cardiaestethus brownianus* White. Male. Apex of abdomen from below. H, *Cardiaestethus fulvescens* (Walker). Male. Apex of abdomen from below. I-J, *Cardiaestethus noumcensis* sp. nov. Male, I, apex of abdomen from below. Female, J, apex of abdomen from below. (All enlarged 40 diameters.)

Head. Length, 500-590; length in front of eyes, 170-210; length behind eyes, 120-140; length of eyes, 170-210; width across eyes, 410-470; width of eyes, 120-150; interocular, 190-210; width of collum, 360-460.

Antennae. I, 120-140; II, 500-530. Remaining segments missing on all specimens.

Rostrum. I, 140-160; II, 380-450; III, 260-280.

Pronotum. Anterior width, 380-470; posterior width, 930-1,000; median length, 400-470; lateral length, 550-600.

Scutellum. Anterior width, 590-650; median length, 450-470; lateral length, 480-550.

Legs	coxa	femur	tibia	tarsi I	II	III	cl.
I	260-320	500-530	520-600	50	70	120	30
II	210-240	520-550	520-640	50	70	120	30
III	310	640-740	800-900				

Total length, 2,810-3,450; total width, 1,030-1,410; length abdomen, 1,360-1,790; length male genitalia, 530; length female genitalia, 350.

Loc. New Zealand: Huia, Auckland (T. E. Woodward, 13 May, 1950, 4 specimens); Paiaka, Manawatu (T. E. Woodward, 8 January, 1950). All specimens in the Woodward Collection.

CARDIASTETHUS ARIDIMPRESSUS sp. nov.

Fig. 1, C-D

Dark brown. Legs, antennae and embolium yellow. Eyes black. Ocelli red. Rostrum paler brown. Membrane fuliginous. Pilosity yellowish.

Flattened oval pilose. Collum very short. Pronotum rectangular (fig. 1, C), slightly convex, marginate anterior angles produced somewhat in front of fore margin. Behind fore margin a slightly raised punctate callus. Collar tenuous. Scutellum triangular, plane, slightly depressed posteriad, with many denticulations laterally. All femora somewhat incrassated. Male genitalia in form of an angular plate with a hook-like process.

The standard measurements (in microns) from 4 specimens are:

Head. Total length, 380-460; length in front of eyes, 120-150; length behind eyes, 50; length of an eye, 200-270; width across eyes, 450-500; width of eye, 120-150; interocular, 170-240; width of collum, 320-400.

Antennae. I, 900-1,000; II, 310-330; III, 190-220; IV, 240.

Rostrum. I, 160-220; II, 330-430; III, 310-330.

Pronotum. Anterior width, 450-520; posterior width, 760-930; median length, 290-450; lateral length, 430-530.

Scutellum. Anterior width, 520-690; median length, 350-480; lateral length, 360-570.

Legs	coxa	femur	tibia	tarsi I	II	III	cl.
I	240-280	400-450	380-450	34	68	103	34
II	220-260	360-400	360-450	34	68	103	34
III	200-260	510-550	530-570	34	68	103	34

Total length, 2,400-2,800; width, 960-1,160; length abdomen, 1,150-1,580; length male genitalia, 240-330; length female genitalia, 172.

Loc. South Australia: Wilpena Pound (G. F. Gross, 3 August, 1951, Holotype ♂, Reg. Nos. E.S.I. 1480 and I20065), Mt. Lofty (Allotype ♀, Reg. No. I20066 and S. B. Curnow, Paratype ♂, Reg. No. I20067), Burnside (J. G. O. Tepper, 5 July, 1884, Paratype ♂, Reg. No. I20068).

CARDIASTETHUS LINCOLNENSIS sp. nov.

Fig. 1, E-F

Very similar in colouration to *C. aridimpressus*. Flattened, elongate oval, pilose. Collum quite long. Pronotum marginate. Lateral margin somewhat sinuate and diverging much more strongly posteriorly than in *C. aridimpressus*. Collar tenuous. Scutellum triangular, plane, slightly depressed posteriorly with many denticulations laterally. Femora not incrassated. Male genitalia very similar to *C. aridimpressus*.

The standard measurements (in microns) from 4 specimens are:

Head. Total length, 470-500; length in front of eyes, 170-210; length behind eyes, 90-120; length of an eye, 170-210; width across eyes, 400-470; width of an eye, 100-140; interocular, 170-210; width of collum, 330-380.

Antennae. I, 100-120; II, 350-430; III, 290-345; IV, 280-310.

Rostrum. I, 90-140; II, 400-470; III, 290-310.

Pronotum. Anterior width, 430-520; posterior width, 900-1,020; median length, 330-350; lateral length, 520-600.

Scutellum. Anterior width, 520-640; median length, 470-590; lateral length, 470-620.

Legs	coxa	femur	tibia	tarsi I	II	III	cl.
I	260-290	500-520	480-520	30	80	100-120	30
II	220-240	460-510	500-530	30	80	100-120	30
III	260	640-670	690-740	30	80	120	30

Total length, 2,070-2,870; width, 1,020-1,140; length abdomen, 1,240-1,480; length male genitalia, 290; length female genitalia, 170-210.

Loc. South Australia: Pt. Lincoln (A. M. Lea, Holotype ♂, Reg. No. I20069 and 1 paratype ♀, Reg. No. I20070), Lucindale (A. M. Lea, 1 paratype ♀, Reg. No. I20071); Tasmania: Daveystown (H. Felix, Allotype ♀, Reg. No. I20072); all in South Australian Museum.

CARDIASTETHUS POWERI White.

Cardiastethus poweri White, 1880, Ent. Mo. Mag. 16, 144.

Piceous brown or piceous black, opaque, clothed with longish cinereous hairs; head anteriorly and posteriorly, pronotum laterally and posteriorly, also

the scutellum apically, embolium basally, clavus and the corium for the most part more or less lighter, sometimes lightly reddish. The third segment of the antennae fuscous brown, fourth reddish, a whitish fuscous nearly round spot before the base of the cuneus, membrane dilutely fuscous brown with three lighter markings, two basally, and the other on the inner margin, veins poorly defined. Rostrum basally piceous, apically somewhat yellowish, legs piceous brown, basally tending lighter in colour, femora apically, the apical half of the tibiae and usually the tarsi brownish yellow, body beneath a shining piceous brown, abdomen medianly lighter. Head and pronotum (anterior part of the disc excepted) transversely rugulose; scutellum lightly rugulose punctate, the posterior lobe of the pronotum anteriorly transversely impressed or (♀) with a small deep fovea; membrane of the female shortened. Length, 1½-2 mm.' (translated from White's Latin description).

Loc. New Zealand.

CARDIASTETHUS BROUNIANUS White

Fig. 1, G

Cardiastethus brounianus White, 1878, Ent. Mo. Mag., 15, 159.

"Piceous brown, clothed with rather long pale hairs; clypeus, anterior margin of the embolium, and the corium rather paler, second joint of the antennae (apex excepted) and legs brownish yellow; membrane dark fuscous, with the outer three nerves margined with whitish. Head, pronotum and scutellum finely transversely rugose; transverse depression of the pronotum nearly obsolete; central depression of the scutellum rather shallow.

Length, 2-2½ mm." (White's description).

There are a number of specimens in the Woodward Collection which seem to fit this description. From some of them the following standard measurements have been obtained.

Head. Length, 450-480; length in front of eyes, 170; length behind eyes, 90; length of eyes, 190-210; width across eyes, 430-450; width of eyes, 100-120; interocular, 240; width of collum, 410.

Antennae. I, 100-120; II, 360; III, 220; IV, 240.

Rostrum. I, 160; II, 310-350; III, 260-310.

Pronotum. Anterior width, 450; posterior width, 1,000; median length, 430; lateral length, 570.

Scutellum. Anterior width, 410; median length, 430; lateral length, 480-500.

Legs	coxa	femur	tibia	tarsi I	II	III	cl.
I	—	520-550	500-520	—	—	—	—
II	—	520	500	—	—	—	—
III	310	670	—	—	—	—	—

Total length, 1,980; total width, 1,100; length abdomen, 1,120-1,210; length male genitalia, 350; length female genitalia, 210.

Loc. New Zealand: Cable Bay, N. Auckland (T. E. Woodward, 27 February, 1951, 3 specimens), Paiaka, Manawatu (T. E. Woodward, 15th January, 1950, by sweeping *Muehlenbeckia australis*, 9 specimens), South West Island, Three Kings (T. E. Woodward, 13 February, 1951, 10 specimens), Great Island, Three Kings, East Point (T. E. Woodward, 15 January, 1951, 3 specimens, *ditto* Tasman Valley, 1 specimen), Otaki River, South of Levin, Wellington Province (T. E. Woodward, 30 January, 1951, 3 specimens), Huia, Auckland (T. E. Woodward, 13 April, 1950, 1 specimen), and Puuakitere, near Kaikohe, North Auckland (T. E. Woodward, 11 February, 1951, one specimen).

CARDIASTETHUS FULVESCENS (Walk)

Fig. 1, H

Xylocoris fulvescens Walker, 1872, Cat. Het. 5, 160.

Cardiastethus ? fulvescens Lethierry and Severin, 1896, Cat. Hem. 3, 250.

Amphiareus fulvescens Distant, 1904, A.M.N.H. (7) 14, 220. Fam. Brit. Ind. Rhyneh. 3, 4, fig. 3.

Cardiastethus fulvescens Poppius, 1909, Act. Soc. Sci. Fenn. 37 (9), 19.

Xylocoris fumipennis Walker *loc. cit.*

Cardiastethus fumipennis Lethierry and Severin *loc. cit.*

Light yellow with long yellow hairs. Generally the apical margin of the corium and seldom the head, pronotum, clavus, the first segment of the antennae, and an apical band on the second, brown.

Sides of pronotum sinuate, disc deeply transversely impressed behind the middle, hind portion punctate. Scutellum medially broadly transversely impressed, anteriorly punctate, terminally striated.

The standard data (in microns) from the three specimens in the South Australian Museum are:

Head. Length, 380-480; length in front of eyes, 140-170; length behind eyes, 70-120; length of eyes, 170-190; width across eyes, 360-430; width of eyes, 120-140; interocular, 120-140; width of collum, 290-310.

Antennae. I, 100-140; II, 360-460; III, 280-290; IV, 280-290.

Rostrum. I, 140; II, 400; III, 210-260.

Pronotum. Anterior width, 310-330; posterior width, 760-810; median length, 310-460; lateral length, 430-570.

Scutellum. Anterior width, 430-570; median length, 330-400; lateral length, 360-450.

Legs	coxa	femur	tibia	tarsi I	II	III	cl.
I	240-290	480-530	510-580	—	—	—	—
II	220-260	480-530	600-670	50	70	100	30
III	260	620-720	770-930	90	100	140	30

Total length, 2,170-2,410; total width, 770-950; length abdomen, 1,070-1,090; length male genitalia, 280; length female genitalia, 120.

Loc. Distributed widely over an area from Ceylon to Queensland. There are three specimens in the South Australian Museum from Malaya: Gap, Frazer's Hill (A. M. Lea and wife), New Guinea: Mt. Lamington, N.E. Papua (C. T. McNamara), and Queensland: Cairns District (A. M. Lea, attracted to light).

CARDIASTETHUS NOUMEENSIS sp. nov.

Fig. 1, I-J

Yellowish brown, eyes reddish brown. Collum, collar of pronotum, and two large patches on the anterior angles, clavus, scutellum, cuneus, embolium apically, and underside brown.

Collum long, third and fourth segments of antennae short. Lateral margins of pronotum rounded with four long hairs and a number of shorter ones, fore margin straight, hind margin excavate. Pronotum strongly raised, immarginate, just anterior to middle a deep curved suture. Scutellum with strong denticulations laterally, impressed behind the middle. Clavus and posterior margin of corium punctate.

Upper surface longly pilose, anal end equipped with long hairs. Male genitalia in the form of a roughly semicircular plate, with about 7 long backwardly directed hairs.

The standard measurements (in microns) from four specimens are:

Head. Length, 380-550; length in front of eyes, 110-220; length behind eyes, 80-90; length of eyes, 160-190; width across eyes, 380-470; width of eyes, 120-160; interocular, 90-160; width of collum, 300-400.

Antennae. I, 90-100; II, 220-360; III, 170-210; IV, 190-240.

Rostrum. I, 120-170; II, 300-450; III, 170-240.

Pronotum. Anterior width, 210-430; posterior width, 830-1,000; median length, 410-450; lateral length, 450-500.

Scutellum. Anterior width, 430-517; median length, 220-360; lateral length, 280-430.

Legs	coxa	femur	tibia	tarsi I	II	III	cl.
I	260-330	380-480	380-470	30	50	90	30
II	190-220	360-460	410-500	30	50	90	30
III	190-260	480-600	620-750	50	70	100	30

Total length, 2,170-2,460; total width, 800-1,020; length abdomen, 1,030-1,330; length male genitalia, 190-270; length female genitalia, 140.

Loc. New Caledonia: Noumea (A. M. Lea, Holotype ♂, Reg. No. I20073, Allotype ♀, Reg. No. I20074, and two paratypes, Reg. Nos. I20075-76) in the South Australian Museum.

CARDIASTETHUS MINUTUS Poppius

Cardiastethus minutus Poppius, 1909, Act. Soc. Sc. Fenn. 37 (9), 20.

Shining, hemielytra duller, clothed with short semi-erect brown hairs. Apical part of corium and cuneus, the second segment of the rostrum and the third and fourth antennal segments brown.

Head depressed, second segment of the antennae not longer than the head is wide, rostrum reaches the fore coxae. The disc of the pronotum is fairly deeply excavate behind the middle and transversely impressed. Corium and elavus very obscurely punctate. There is one specimen belonging to this species in the South Australian Museum and its standard measurements are:

Head. Length, 360; length in front of eyes, 140; length behind eyes, 90; length of eyes, 110-140; width across eyes, 330; width of eyes, 100-120; interocular, 100; width of collum, 260.

Antennae. I, 90; II, 220; remaining segments missing.

Rostrum. I, 90; II, 280; III, 220.

Pronotum. Anterior width, 330; posterior width, 720; median length, 310; lateral length, 600.

Scutellum. Anterior width, 400; median length, 350; lateral length, 360-380.

Legs	coxa	femur	tibia	tarsi I	II	III	cl.
I	—	380-400	380-410	30	70	90	30
II	170	350-380	410-430	30	70	90	30
III	170-190	450-470	580-600	30	90	100	30

Total length, 2,300; total width, 830; length abdomen, 1,100; length male genitalia, 170.

Loc. New Guinea: Mt. Lamington, N.E. Papua, 1,300-1,500 ft. (C. H. McNamara).

PORONOTELLUS Kirkaldy

The genus *Poronotellus* has proved to be rather common in these regions and the species have proved extremely difficult to separate. To date it has not proved possible to come to any definite conclusions about the status of forms. Accordingly, it is intended to investigate more fully this problem and to present the results in a further paper to comprise, together with additional material on species in the other two subfamilies, part III of this revision.

Therefore the sections of the ecology and zoogeography of the Anthocoridae have been introduced here, instead of at the end of the whole systematic account as originally intended.

ECOLOGY OF ANTHOCORIDAE

The minor habitats occupied by Australian and Pacific Anthocoridae are fairly varied. Those species of *Cardiastethus* for which the minor habitat is known are all subcortical, especially on eucalypts, with the exception of the two type specimens of *Cardiastethus inquilinus* China, which were found in an Oxyopid spider's nest. This spider's nest was located in a mallee area of South Australia in which in the main the only vegetation is depauperate species of *Eucalyptus*, mostly of the peeling "gum barked" type. These mallees very nearly duplicate the minor habitat of such eucalypts as *Eucalyptus camaldulensis* on which *C. aridimpressus* nov. frequently occurs. Therefore it is not unlikely that *C. inquilinus* is also usually subcortical under eucalypt bark.

The widespread *Xylocoris flavipes* Reuter. occurs in stored grains. The family seems definitely to be predaceous, though it is not clear whether all are egg predators like are *Orius australis* (China) and *Orius insidiosus* (Say) or whether some of the litter dwelling forms feed also on Collembola and mites. The habits of *Xylocoris flavipes* and of *Cardiastethus* spp. suggest that they may be egg predators for adult animals small enough for them to feed on, are rare in their two preferred minor habitats.

The widespread *Lycocoris campestris* (Fab.) is at home in crevices and cracks in man made dwellings and is the only Anthocorid known to bite man.

The remaining forms all seem to be most likely associated with the litter layers of the forest floor. This has been proven for *Falda queenslandica* Gross and several species of *Lasiochilus*.

The members of the family are definitely favoured by hot and warm conditions. There are therefore considerably more species in the tropics than in the temperate zones, and in any given temperature zone more species in the forest major habitats than in adjacent grassland or desert. Of the known Australian species only *Lyctocoris campestris*, *Cardiastethus inquilinus* and *C. aridimpressus* occur in major habitats drier than dry sclerophyll forest. On the other hand, no fewer than twelve species occur in the Queensland wet forests.

ZOOGEOGRAPHY OF AUSTRALIAN ANTHOCORIDAE

This preference for hot and wet conditions of Anthocoridae described above has considerable bearing on their use in helping to elucidate the puzzling facts of the present distribution of the Australian biotas and its relation to past climatic history.

The present primary disjunction of the terrestrial biotas is largely a resultant of the distribution of land and sea in past geological ages. Within any one area which has had a geological history of relative stability and unity, any disjunction now evident is mostly an outcome of the past climatic history. Some groups of the biota (e.g., plants and their associated herbivorous insects) are affected more than others (e.g., mammals, carnivorous insects, etc.) by these climatic changes.

In Australia the biota has at least two distinct elements with perhaps two, possibly three, other elements. The first of these is the "old world tropical" or "northern" element variously called Tropical, Torresian, Papuan or Indo-Malayan. The last has priority but does not necessarily reflect the origin of the element, merely its present centre of distribution and the pathway by which it entered Australia. Some constituents may be but birds of passage in the Indo-Malayan tropics, having perhaps had their greatest period of development in the northern temperate areas. This Indo-Malayan element includes amongst animals the insect families Anthocoridae, Pyrrhocoridae, Flatidae, Ricaniidae, etc. (Hemiptera) Papilionidae (Lepidoptera), etc., and of the vertebrate groups the whole of the Australian eutheria and metatheria and modern Australian reptiles and amphibians. The Indo-Malayan element of the flora includes such genera as *Eugenia*, *Ficus*, *Terminalia*, *Erythrina* (Coral trees), *Cochlospermum* (Kapok trees), *Adansonia* (Baobab), *Cocos* (Coconut palm) and *Pandanus*. Also (see Eyrarian element) *Hibiscus*, *Malva*, *Acacia*, *Cassia* and *Eucalyptus* are really a part of this biota. Generally members of this element tend to be limited by the southern boundary of the northern Australian tropical forest, savannahs and savannah woodlands.

The second element of the biota is the so called "southern" element whose members show three different types of distribution, namely:

- (1) Endemic to Australia and adjacent regions, e.g., Casuarinaceae in the plants and Melolonthinae (Coleoptera) amongst the animals.
- (2) Affinities with New Zealand and often South America, e.g., the plant genera *Nothofagus*, *Araucaria*, part of the family Podocarpaceae and the family Epacridaceae and the animal groups Peloridiidae, Isoderminae (Hemiptera), part of the Tiphiidae (Hymenoptera), and of the Dynastinae (Coleoptera).
- (3) Affinities with South Africa and Madagascar only (Proteaceae, part of Podocarpaceae).

Some authors recognize one or more of these three as being entirely different biotas, but it will probably prove that (2) and (3) are but wider ranging wind borne or island hopping members of (1), which extended their distribution during Pleistocene and earlier changes of sea level. This whole southern element, or various parts of it, has been called by a variety of names (e.g., Antarctic, Bassian and Autochthonian) and it generally tends to be limited by the northern border of the southern humid regions.

Lastly, there is the desert biota. This has been considered a distinct element by some authors (e.g., "Eyrean" of Spencer and "Eremitian" of Tate), but this can only be justified on the basis of the great modification that plants and most animals must adopt in order to survive in the desert. Apart from these physiologically essential modifications, the Australian desert biota is clearly comprised of demonstratable elements of the contiguous "northern" and "southern" biotas. Actually, in plants it is much the same group the world over that may enter desert or similar areas, e.g., *Acacia* (Australian, African, Asian and North American deserts, note also the closely related North American *Prosopis*), *Atriplex* (Australian, African, Asian and North American deserts), *Triodia* (Australian, Asian and North American deserts), and many others.

This restriction on what groups of plants and animals can enter desert regions, together with the tendency of strong prevailing winds to blow around the world latitudinally (e.g., parallel to the deserts, not across them) may well explain the primary disjunction of the Australian biota into two or (counting the Eyrean) three elements. For if the continent has been divided latitudinally by the same belt of desert as now exists (this would have extended probably from coast to coast before the Mount Koseiushko and New Guinea uplifts), the southern element would have been effectively isolated from the northern. If this

state of affairs came into being at the beginning of the Tertiary, the "southern" element would have had time to develop its distinctive features.

We cannot assume this barrier to have been any earlier than the beginning of the Tertiary, for during the Upper Cretaceous plant species were notoriously widespread. During the progress of the Tertiary progressive restriction of distribution is evident in plants. (Cookson and Pike, 1953, a, b, 1954; Cookson, 1953, a, b, 1954).

The presence of a few members of the one element in the area occupied in the main by members of the other, and the presence of both together in the desert, seems to be explicable mostly on the basis of desert adaption, for it is usually groups capable of desert adaption that occur in the region of the other element. A whole suite of adaptable genera of the Indo-Malayan element has moved into the desert from the north (*Acacia*, *Cassia*, *Malva*, *Eucalyptus*, *Hibiscus*, and *Melaleuca* amongst the plants) or has been trapped in favourable pockets during one of the north or south oscillations of the position of the continuous band of desert (in plants *Livistona mariuae*, *Macrozamia macdonnelli*, and *Ficus platypoda*) with some actually crossing the southern boundary of the desert into the southern humid formations (*Acacia*, *Eucalyptus*, *Melaleuca*). Equally, a group of adaptable genera were able to penetrate the desert from the south and usually make their way through to the north (*Hakea*, *Grevillea*, *Brachychiton* amongst the plants).

At the end of the Pliocene the Kosciusko uplift formed a moist corridor of forest formations traversing the area formerly covered by part of the desert and breaking the continuity of this belt in the east. This gave considerable opportunity for mixing the "northern" and "southern" elements, and this seems to have occurred. As is to be expected, the greatest mixing has occurred in this north-south moist corridor with the effect falling off the further the distance from the corridor until, in such places as the Darwin and Perth areas, practically the only members of an extraneous element present are those that have come through via the desert. No group shows the effect of this moist corridor better than the Anthocoridae, for this undoubtedly tropical or "northern" group have fourteen species in Queensland, six in New South Wales, five in Victoria, five in South Australia (one of which is introduced), and one (introduced) in Western Australia.

This theory of the permanence of the desert belts is not in accord with the concept of a vast aridity covering the whole continent as postulated by Crocker and Wood (1947) during the "mid recent high" in sea level. Their "great arid" hypothesis is at the moment under criticism from other quarters. Tidale

(1947, a and b, 1949, 1952) and Condon (1954) have shown that most zoological data, and even a considerable part of the botanical distributions employed by Crocker and Wood as proof of their "great arid," are better explained by assuming a steady increase in aridity in the southern regions from the end of the Pleistocene right up to the present. This may involve a steady shifting south of the desert belt.

Some investigations of the author have tended to confirm these later views. The discovery of "myall" (*Acacia soudeni*) growing near the southern end of Lake Eyre South suggests rather an earlier continuous belt of "myall" stretching from Kingoonya around the north end of Lake Torrens to the Broken Hill district and disjoined into two species by the present aridity rather than that the distribution of the two species, *A. soudeni* and *A. loderi* reflects emergence from refuges in the Gawler Ranges and Flinders Ranges into which they retreated during the "great arid." The Gawler Ranges would provide little or no better conditions for such a plant than the surrounding countryside for the ranges themselves are of porphyry, onto which myall never ventures, with wide loam flats (on which myall now occurs) between, and which receive little, if any, more rain than the main areas of myall distribution.

Even more difficult to explain by the "great arid" are the presence of such forms as *Cardiastethus aridimpressus* and the butterfly *Heteronympha merope merope* in favoured gorges in Wilpena Pound, over 90 miles away from their next main occurrences at Mount Remarkable. (*Heteronympha merope merope* also occurs in favoured gorges in the Elder Range 10 miles west of Wilpena Pound.) A stunted mallee form of *Eucalyptus elaeophora* occurs in the highest 300 feet of the Elder Range (3,700 feet) and as a similar though less stunted patch in the Clare region. Its main occurrence is as large trees on Mt. Remarkable and in Alligator Gorge, 90 miles to the south or 70 miles to north respectively. Both the Elder Range patch and the Clare patch could hardly have survived more aridity than at present exists, nor could the small clumps of only a few tree ferns (*Dicksonia antarctica*) present in Morialta Gorge, and some other isolated localities in South Australia when the white man came. This also applies to the small patch now existent at the Silverband Falls in the Grampians of Victoria.

ERRATUM. On p. 153 of Part 1 of this paper *Lasidiella* should read as *Lasiellidea*.